REMARKS

In response to the Final Office Action mailed September 4, 2007, Applicants respectfully request reconsideration. Claims 1-12 are pending in this application, with claims 1-4 being independent. The Office Action has maintained the rejection of claims 1-12 under 35 U.S.C. §103(a) as purportedly being unpatentable over Wariishi et al. (U.S. Patent No. 6,376,765) in view of Osuka (WO 02/14322). Applicants respectfully traverse these rejections.

The Office Action uses the teaching, suggestion or motivation (TSM) test as the rationale for finding the present claims to be obvious over Wariishi et al. in view of Osuka, and sets forth two rationales that one of ordinary skill in the art purportedly would have used to modify Wariishi et al. in view of Osuka to replace Wariishi's photoelectric conversion dye with Osuka's molecules. First, the Office Action relies upon Osuka's description of the possible benefits of linked porphyrin molecules as a conductive wire. Second, the Office Action states that one of ordinary skill in the art would have modified Wariishi because Osuka describes that linked porphyrin is interesting for its high absorbance. Applicants disagree with both of these rationales because neither a conductive wire or a material with high absorbance suggests any capability whatsoever of performing photoelectric conversion: a required property of Wariishi's solar cell. The Office Action has provided no evidence or rationale explaining why the physical property of absorbance suggests the capacity to convert light into electricity. Such a rationale is completely absent from the cited references. In fact, one of ordinary skill in the art would realize that many materials absorb light without converting it to electricity. Therefore, the present rejection is deficient from a scientific perspective because light absorption does not require conversion into electricity. Furthermore, it is clear that the Office Action relies entirely upon hindsight reasoning based upon Applicants' disclosure. For these reasons, the rejections are improper and should be withdrawn.

1. A Person of Ordinary Skill in the Art Would Not Have Replaced a Photoelectric Conversion Dye with a Molecular Wire.

The Office Action relies upon Osuka (Col. 1, line 61 – Col. 2, line 2) which describes linked porphyrin arrays as being promising as a molecular wire. According to the Office Action's rationale, one of ordinary skill in the art purportedly would have modified Wariishi's photoelectric conversion dye to include Osuka's linked porphyrin molecules because Osuka states that such molecules are promising as a molecular wire. Applicants respectfully disagree because a photoelectric conversion dye is quite different from a molecular wire: a wire only serves to conduct electricity, not to convert light into electricity. If the dye of Wariishi's solar cell were simply replaced with an arbitrary type of conductive material there is no reason to expect that such a material could perform photoelectric conversion. One of ordinary skill in the art would not have been motivated to remove the dye from Wariishi's solar cell and replace it with a molecular wire that is incapable of performing the necessary function of photoelectric conversion. Osuka provides no teaching or suggestion that Osuka's polymers would be in any way suitable for photoelectric conversion. For these reasons, the rationale provided in the Final Office Action with respect to Osuka's conductive properties is simply incorrect from the standpoint of a person of ordinary skill in the art, who would understand that a photoelectric conversion dye should not be replaced with a conductive wire if a solar cell is to function properly. Therefore, the Office Action's "conductive wire" rationale for combining Wariishi et al. and Osuka is improper.

2. A Person of Ordinary Skill in the Art Would Understand That Absorbance is Different From Photoelectric Conversion.

The Office Action also relies upon Osuka's description of absorbance properties as purportedly providing a rationale for one of ordinary skill in the art to have modified Wariishi's device. The Office Action cites the following passage of Osuka:

> In this line, syntheses of porphyrin polymers or oligomers bearing long, rigid, planar, and thus the exploration of extensively π-conjugated

> electronic systems and new devices based on the strong absorbance in the visible region, strong fluorescence and phosphorescence, and small optical HOMO-LUMO energy gap have been actively attempted. (Col. 1, lines 46-52)

Based on this passage of Osuka, the Office Action reasons: "Therefore, Osuka teaches linked porphyrin arrays, or porphyrin polymers, that are capable of performing photoelectrical conversion [sic] such as absorbing light and conducting electrons like a dye." Applicants respectfully disagree. Contrary to this statement in the Office Action, Osuka does not teach or suggest that porphyrin polymers are capable of performing photoelectric conversion. Rather, Osuka states that synthesis of porphyrin polymers has been attempted based on strong absorbance in the visible region. Absorbance is <u>not</u> the same as photoelectric conversion, as one of ordinary skill in the art would readily appreciate. Absorbance is a measure of the amount of light absorbed by a material, or the material's transparency. Applicants have enclosed herewith pages of a textbook entitled "Electronic Properties of Materials," which defines the absorbance α to be the inverse of the characteristic penetration depth W, which is the distance into a material at which the intensity of a light wave has decreased by 37% (1/e). As another example, Merriam Webster's dictionary defines the word "absorbance" to be: "the ability of a layer of a substance to absorb radiation expressed mathematically as the negative common logarithm of transmittance." (Merriam Webster's dictionary online edition as of November 28, 2007). However, the absorbance, or the transparency of the material is not the same as the capability of the material to achieve photoelectric conversion. Photoelectric conversion is only one physical mechanism by which a material may absorb light. Other light absorbance mechanisms are commonly known in the art. As one example, a material may absorb light by transforming photon light energy into thermal energy (heat). Therefore, photoelectric conversion is not implied by the use of the term "absorbance." MPEP §2144.03 states that "if Applicant challenges a factual assertion not properly officially noticed or not properly based upon common knowledge, the Examiner must support the finding of adequate evidence." The Office Action has not provided any evidence or rationale to support the idea that absorbance implies a capability for

photoelectric conversion. For these reasons, the Office Action's rationale for combining the references based on "absorbance" is improper.

3. The Rejections are Improper Because they are Based Entirely Upon Hindsight Reasoning in View of Applicants' Disclosure.

The Office Action's link between absorption and photoelectric conversion appears to be based entirely upon hindsight in view of Applicants' specification. The Office Action has provided no link between Osuka's mention of absorbance and a suitability to perform photoelectric conversion, the very purpose of Wariishi's solar cell. Instead, it appears that the Office Action has used Applicants' specification as a road map for rejecting Applicants' claims, which is impermissible under MPEP §2145. The Office Action has not pointed to any rationale or teaching in Wariishi or Osuka that bridges the gap between the physical property of absorbance and the physical property of photoelectric conversion. By contrast, these properties are described in the Background section of the present application (pages 2-3).

> In the dye-sensitized type solar cell, a chlorophyll derivative or a zinc complex of porphyrin as well as a ruthenium bipyridine complex, etc. have been proposed as dyes (see Japanese patent Application Laid-Open No. 2002-63949). These dyes have low photoelectric conversion characteristics, so that they can not be satisfactorily put to practical use for the solar cells.
>
> As a reason why the photoelectric conversion characteristics of them are low, a fact that the absorption of the dyes in a visible radiation area is low may be considered. The existing dyes such as a monomer of zinc porphyrin, the chlorophyll derivative, the ruthenium bipyridine complex, etc. have low absorbance in the visible radiation area. In recent years, a stable dye having a high absorption in the visible radiation area has been developed by Osuga et al. (see Science Vol. 293, p79, 2001, Japanese Patent Application Laid-Open No. 2001-294591 and Japanese Patent Application Laid-Open No. 2002-53578.). (emphasis added)

As seen from the above, it is Applicants' disclosure that describes the deficiencies in prior art solar cells and provides a suitable solution, not Wariishi or Osuka. The rejections are improper because the Office Action can only take into account knowledge

within the level of one of ordinary skill in the art at the time the claimed invention was made, and not knowledge gleaned only from Applicants' disclosure. Therefore these rejections are clearly improper as being based in impermissible hindsight in view of Applicants' disclosure.

4. The Claimed Invention would not have been Obvious in View of Wariishi and Osuka under the TSM test or any other test.

As discussed above, the rationales provided in the Office Action are insufficient to support an obviousness rejection using the TSM test. In addition, the claimed invention would not have been obvious even if the Office Action were to apply a different test. First, there is simply no disclosure in the references that bridges the gap between absorption characteristics and the capability of performing photoelectric conversion. The cited art provides no suggestion that photoelectric conversion is predictable simply based on absorbance characteristics. In addition, it would not have been obvious to try the claimed invention because Wariishi et al. describes an extremely large number of possible dye compounds of which porphyrin is only one example. One of ordinary skill in the art certainly would not attempt arbitrary modifications of a large number of compounds based solely on speculative statements made in other references. For at least these reasons, the claimed invention would not have been obvious to one of ordinary skill in the art based on Wariishi and Osuka. Therefore, Applicants respectfully request that these rejections be withdrawn.

CONCLUSION

In view of the above remarks, applicant believes the pending application is in condition for allowance.

A Notice of Allowance is respectfully requested. The Examiner is requested to call the undersigned at the telephone number listed below if this communication does not place the case in condition for allowance.

If this response is not considered timely filed and if a request for an extension of time is otherwise absent, Applicant hereby requests any necessary extension of time. If there is a fee occasioned by this response, including an extension fee, that is not covered by an enclosed check, please charge any deficiency to Deposit Account No. 23/2825.

Dated: December 4, 2007

Respectfully submitted,

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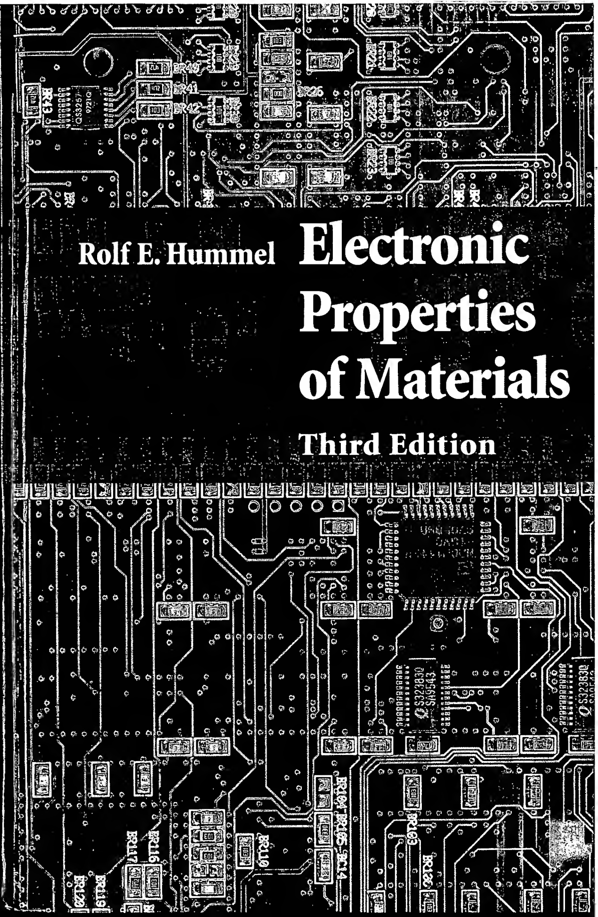
Electronic Properties of Materials

Third Edition



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ın Depth, W, and Damping Constant,
).

t glass	Graphite	Gold
	6×10^{-6}	1.5×10^{-6}
$\times 10^{-7}$	0.8	3.2

$$k = \frac{\sigma}{2\pi\varepsilon_0 \nu}. \qquad (10.14)$$

lled the real and the imaginary parts of
:spectively. (ε_1 in (10.13) is identical to ε
rption product or, briefly, the **absorption**.
nsulators ($\sigma \approx 0$) it follows from (10.11)
hen (10.10) reduces to $\varepsilon = n^2$ (**Maxwell**

d (10.14) one obtains

$$\cdot \varepsilon \Big) = \frac{1}{2}\left(\sqrt{\varepsilon_1^2 + \varepsilon_2^2} + \varepsilon_1\right), \qquad (10.15)$$

$$\cdot \varepsilon \Big) = \frac{1}{2}\left(\sqrt{\varepsilon_1^2 + \varepsilon_2^2} - \varepsilon_1\right). \qquad (10.16)$$

10)–(10.16) are only valid if ε, σ, n, and k
gth, because these "constants" are wave-
ncies, however, the d.c. values for ε and σ
ition, as will be shown later. Finally, it
juations are only valid for optically iso-
a tensor.
ı we replace the index of refraction by the
This yields

$$i\omega\left(t - \frac{z(n - ik)}{c}\right)\Bigg], \qquad (10.17)$$

$$\underbrace{\frac{\omega k}{c} z\Bigg]}_{\text{litude}} \cdot \underbrace{\exp\left[i\omega\left(t - \frac{zn}{c}\right)\right]}_{\text{Undamped wave}}. \qquad (10.18)$$

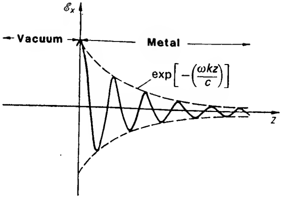

Figure 10.4. Modulated light wave. The amplitude decreases exponentially in an optically dense material. The decrease is particularly strong in metals, but less intense in dielectric materials, such as glass.

Equation (10.18) is now the complete solution of the wave equation (10.4). It represents a damped wave and expresses that in matter the amplitude decreases exponentially with increasing z (Fig. 10.4). The constant k determines how much the amplitude decreases, i.e., k expresses the degree of damping of the light wave. We understand now why k is termed the *damping constant*.

The result which we just obtained is well known to electrical engineers. They observe that at high frequencies the electromagnetic waves are conducted only on the outer surface of a wire. They call this phenomenon the *(normal) skin effect*.

10.4. Characteristic Penetration Depth, W, and Absorbance, α

The field strength, $\mathscr{E}$, is hard to measure. Thus, the intensity, I, which can be measured effortlessly with light sensitive devices (such as a photodetector, see Section 8.7.6) is commonly used. The intensity equals the square of the field strength. Thus, the damping term in (10.18) may be written as

$$I = \mathscr{E}^2 = I_0 \exp\left(-\frac{2\omega k}{c} z\right). \qquad (10.19)$$

We define a **characteristic penetration depth**, W, as that distance at which the intensity of the light wave, which travels through a material, has decreased to $1/e$ or 37% of its original value, i.e., when

$$\frac{I}{I_0} = \frac{1}{e} = e^{-1}. \qquad (10.20)$$

This definition yields, in conjunction with (10.19),

$$z = W = \frac{c}{2\omega k} = \frac{c}{4\pi \nu k} = \frac{\lambda}{4\pi k}. \tag{10.21}$$

Table 10.1 presents values for k and W for some materials obtained by using sodium vapor light ($\lambda = 589.3$ nm).

The inverse of W is sometimes called the (exponential) *attenuation* or the **absorbance**, which is, by making use of (10.21), (10.14), and (10.11),

$$\alpha = \frac{4\pi k}{\lambda} = \frac{2\pi \varepsilon_2}{\lambda n} = \frac{\sigma}{n c \varepsilon_0} = \frac{2\omega k}{c}. \tag{10.21a}$$

It is measured in cm^{-1}, or, when multiplied by 4.3, in decibels (dB) per centimeter (1 dB $= 10 \log I/I_0$).

10.5. Reflectivity, R, and Transmittance, T

Metals are characterized by a large reflectivity. This stems from the fact that light penetrates a metal only a short distance, as shown in Fig. 10.4 and Table 10.1. Thus, only a small part of the impinging energy is converted into heat. The major part of the energy is reflected (in some cases close to 99%, see Table 10.2). In contrast to this, visible light penetrates into glass much

Table 10.2. Optical constants for some materials ($\lambda = 600$ nm)

	n	k	R %[b]
Metals			
Copper	0.14	3.35	95.6
Silver	0.05	4.09	98.9
Gold	0.21	3.24	92.9
Aluminum	0.97	6.0	90.3
Ceramics			
Silica glass (Vycor)	1.46	[a]	3.50
Soda-lime glass	1.51	[a]	4.13
Dense flint glass	1.75	[a]	7.44
Quartz	1.55	[a]	4.65
Al_2O_3	1.76	[a]	7.58
Polymers			
Polyethylene	1.51	[a]	4.13
Polystyrene	1.60	[a]	5.32
Polytetrafluoroethylene	1.35	[a]	2.22
Semiconductors			
Silicon	3.94	0.025	35.42
GaAs	3.91	0.228	35.26

[a] The damping constant for dielectrics is about 10^{-7}; see Table 10.1.
[b] The reflection is considered to have occurred on one reflecting surface only.